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Data handling, evaluation and unfolding methods for radionuclide spectrometry based on low-temperature calorimetric detectors

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Metallic Magnetic Calorimeters (MMCs) are energy-dispersive low-temperature detectors that are particularly suitable for radionuclide spectrometry over wide energy ranges and with high energy resolution. Within the European Metrology Research Project MetroBeta, MMCs are utilized for beta spectrometry. To obtain a high-resolution beta spectrum with enough statistics to allow a shape analysis, a large number of decays, in the order of 10^6 , need to be recorded. A continuous digital data stream for pulse signal detection at high sampling rates may then generate data sets of up to one terabyte in size.

This contribution presents a database approach that enables sensible pulse data handling and sorting as well as spectrum evaluation. Individual signal pulses are identified from raw data streams, sorted, filtered and analyzed. The processed pulse data along with the corresponding processing and analysis parameters are tabulated into a pulse database. The hdf5 data format has been chosen for the data handling and sorting for compactness, high compatibility and the capability of rapid querying. Analysis procedures have been implemented in Python using compiled code packages such as NumPy, pyTables and pandas.

However, even if the beta emitters are completely embedded in 4π absorbers, the obtained spectrum may need additional corrections. Notably for beta particles with energies of a few hundred keV or more, fractions of the overall electron energy may get lost due to bremsstrahlung which escapes from the absorber. In this case, it is necessary to apply an unfolding algorithm to correct for distortions in the measured spectrum. The unfolding algorithm is a matrix inversion method based on large scale energy-bin wise Monte Carlo simulations. It is well suited to correct beta spectra measured in composite microcalorimeters with well-defined absorbers, as is demonstrated by analyzing experimentally determined beta spectra within the scope of the MetroBeta project.

Less than 5 years of experience since completion of Ph.D

Y

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